AMENDMENTS TO THE SPECIFICATION

Please replace paragraph [0007], the paragraph bridging pages 4 and 5, with the following amended one:

[0007] A spark plug of the present invention includes a nearly tubular insulator having an axial through hole and a first insulator stepped portion that reduces in outer diameter toward a front end side, a rod-shaped center electrode disposed in the through hole of the insulator, a metallic shell having a first metallic shell stepped portion that reduces in inner diameter toward a front end side and supporting the insulator through engagement of the first metallic shell stepped portion and the first insulator stepped portion by interposing therebetween a packing, and a ground electrode connected at an end to a front end surface of the metallic shell and facing at the other end portion toward the center electrode for thereby forming a spark discharge gap between the other end portion of the ground electrode and the center electrode, characterized in that the insulator and the metallic shell, when observed in a section made by a plane including the axis of the spark plug, have therebetween a gap of less than 0.45 mm at a more front end side than an engagement position of the packing and the fist insulator stepped portion, and the gap is provided axially from a most front end side engagement position of the packing and the first insulator stepped portion as a starting point to a finishing point that is apart from the starting point by 1.2 mm or more toward a front end side while being apart from the front end surface of the metallic shell by ~~8.0~~7.9 mm or more toward a rear end side.

Please replace paragraph [0008], the first full paragraph on page 5, with the following amended one:

[0008] Further, the spark plug of the present invention is characterized in that the gap is provided axially from a most front end side engagement position of the packing and the first insulator stepped portion as a starting point to a finishing point that is apart from the starting point by 1.5 mm or more toward a front end side while being apart from the front end surface of the metallic shell by ~~10~~9.9 mm or more toward the rear end side.

Please replace paragraph [0014], the paragraph bridging pages 6 and 7, with the following amended one:

[0014] Further, the spark plug of the present invention is characterized in that the packing is made of a material having a thermal conductivity of 200W/m · k or more~~, in addition to the structure of the invention described in any of claims 1 to 7~~.

Please replace paragraph [0019], the first full paragraph on page 8, with the following amended one:

[0019] According to the spark plug of the present invention, since when observed in a section made by a plane including the axis, the axial length of the gap between the insulator and the metallic shell, which gap is less than 0.45 mm and positioned at a more front end side than the engagement position of the packing and the first insulator stepped portion, is 1.2 mm or more, the heat received by the insulator is transmitted to the metallic shell rapidly. Accordingly, good removal of heat is attained and the pre-ignition can be effectively prevented. Further, since

intrusion of unburnt gas (carbon) into the engagement gap between the insulator and the metallic shell is assuredly blocked, fouling of the front end side portion of the insulator can be prevented and an improved fouling resistance can be attained. Further, since the finishing point of the gap of less than 0.45 mm is apart from the front end surface of the metallic shell by ~~8.0~~7.9 mm or more, "internal firing" (phenomena of spark discharge being caused inside the metallic shell and in the gap between the metallic shell and the insulator) due to carbon adhered to the front end side of the insulator is hard to be caused.

Please replace paragraph [0025], the paragraph bridging pages 10 and 11, with the following amended one:

[0025] Further, according the spark plug of the present invention, since the rear end of the second insulator stepped portion is axially apart from the rear end of the second metallic shell stepped portion as a starting point by an amount ranging from –0.5 to 3 mm wherein the amount apart from the starting point toward the front end side is designated by a positive value, a sufficient amount of heat radiation from the heated insulator to the metallic shell can be obtained. Accordingly, the area of the inner circumferential surface of the metallic shell base portion ~~transmitted from the insulator base portion to the metallic shell base portion~~ can be made sufficiently large, thus making it possible to obtain a sufficient amount of heat radiation from the insulator to the metallic shell and improve the heat resistance. Further, since intrusion of unburnt gas into the engagement gap between insulator and the metallic shell can be prevented further assuredly, fouling of the front end side portion of the insulator can be prevented further assuredly

and the interior firing due to carbon adhered to the front end side of the insulator becomes further hard to be caused.

Please replace paragraph [0029], the first full paragraph on page 12, with the following amended one:

[0029] Further, according to the spark plug of the present invention, since the distance <u>from the front end of the metallic shell</u> to the most front end side engagement position of the packing and the first insulator stepped portion is 2 mm or more, it becomes possible to prevent the metallic shell from being excessively heated at the front end side and improve the heat resistance.

Please replace paragraph [0035], the paragraph bridging pages 17 and 18, with the following amended one:

[0035] Further, as shown in FIGS. 1 and 2, at a more front end side than the tool engagement portion 11 of the metallic shell 1 is formed a metallic shell base portion 54, and at the front end side of the metallic shell base portion 54 in the direction of the axis O are formed a metallic shell smaller diameter portion 56 protruding radially inward of the metallic shell 1 and a first metallic shell stepped portion 55 connecting between the metallic shell smaller diameter portion 56 and the metallic shell base portion 54. Further, at the front end side of the metallic shell smaller diameter portion 56 are formed a metallic shell larger diameter portion 58 of an inner diameter intermediate between those of the metallic shell base portion 54 and the metallic shell smaller diameter portion 56 and a second metallic shell stepped portion 57 connecting between the metallic shell smaller diameter portion 56 and the metallic shell ~~smaller~~<u>larger</u> diameter portion

58. Accordingly, the metallic shell base portion 54, the first metallic shell stepped portion 55, the metallic shell smaller diameter portion 56, the second metallic shell stepped portion 57 and the metallic shell larger diameter portion 58 are formed in this order in the direction of the axis O from the tool engagement portion 11 of the metallic shell 1 to the front end. In the meantime, the first metallic shell stepped portion 55 is a portion for engagement with a first insulator stepped portion 27 of the insulator 2 which will be described later. Further, as shown in FIG. 1, at an intermediate portion of the metallic shell 1 in the direction of the axis O is formed a flange portion 61 protruding radially outward. Adjacent the rear end side (the upper end portion in FIG. 1) of the thread portion 7 in the direction of the axis O, i.e., on a seating surface 62 of the flange 61 is disposed a gasket 10.

Please replace paragraph [0046], the paragraph bridging pages 24 and 25, with the following amended one:

[0046] Then, description will be made as to the angle θ between the insulator intermediate diameter portion 28 and the second insulator stepped portion 29 of the insulator 2 will be described. As shown in FIGS. 2 and 3, it is assumed that when observed in a section made by a plane including the axis O, θ is an angle between the imaginary ~~plane~~line extending from the outer circumferential surface of the insulator intermediate portion 28 of the insulator 2 toward the front end side and the second insulator stepped portion 29. In this connection, since the outer circumferential surface of the insulator ~~base~~intermediate diameter portion 28 is parallel with the axis O, the angle θ indirectly represents the angle between the axis O and the second insulator stepped portion 29. In the spark plug 100 of the first embodiment, the angle θ is adjusted to 10°

or more. By adjusting the angle θ to 10° or more, a large space can be attained between the metallic shell larger diameter portion 58 and the insulator smaller diameter portion 30. Accordingly, it becomes possible to prevent the internal firing that is a spark discharge between the metallic shell 1 and the insulator 2. On the other hand, when the angle θ is adjusted to less than 10°, the above-described effect cannot be attained. In the meantime, confirmation of effect attained by adjustment of the angle θ between the imaginary ~~plane~~line formed by extending the outer circumferential surface of the insulator intermediate portion 28 of the insulator 2 toward the front end side and the second insulator stepped portion 29 will be described later.

Please replace paragraph [0048], the paragraph bridging pages 26 and 27, with the following amended one:

[0048] Then, the length Z of the insulator intermediate portion 28 in the direction of the axis O will be described. As shown in FIGS. 1 and 2, at the front end side of the first insulator stepped portion 27 of the insulator 2 is formed the second insulator stepped portion 28. When observed in a section made by a plane including the axis O as shown in FIG. 2, the outer circumferential surface of the insulator intermediate diameter portion 28 extends in parallel with the axis O. Further, in the spark plug 100 of the first embodiment, assuming that Z is the axial length of the insulator intermediate diameter portion 28, the length Z of the insulator intermediate diameter portion 28 is adjusted so as to be in the range from 1.0 to 6.0 mm. Namely, the axial distance between the front end of the first insulator stepped portion and the rear end (F) of the second insulator stepped portion is in the range from 1.0 to 6.0 mm. For this reason, the thermal value

(heat radiation rate, removal of heat) of the spark plug 100 is adjusted and it becomes possible to improve the heat resistance and the fouling resistance. For example, if the length Z of the insulator intermediate portion 28 exceeds 6.0 mm, the internal firing that is caused by carbon adhered to the front end side of the insulator 2 is liable to be caused. Further, if the length Z is less than 1.0 mm, the temperature of the front end portion of the spark plug becomes higher such that the heat resistance is largely deteriorated since the removal of heat becomes worse (the thermal value is lowered) though the fouling resistance is increased. In the meantime, recognition of the effect attained by adjustment of the length Z of the insulator intermediate portion 28 will be described later.

Please replace paragraph [0056], the first full paragraph on page 32, with the following amended one:

[0056] As shown in FIG. 4, with the minimum clearance β'=0.4 mm, the number of cycles for attaining 10MΩ was 8. With the minimum clearance β'=0.43 mm, the number of cycles for attaining 10MΩ was 8. With the minimum clearance β'=0.45 mm, the number of cycles for attaining 10MΩ was 4. With the minimum clearance β'=0.48 mm, the number of cycles for attaining 10M was 4. From comparative observation of the data of FIG. 4, it was found that with β'= less than 0.45 mm, the number of cycles for attaining the 10MΩ was stably high, i.e., eight or more. On the contrary, with the minimum clearance β'=0.45 mm or ~~less~~more, the number of cycles for attaining 10MΩ was reduced, i.e., four. It is considered that this is because the minimum clearance β' was adjusted so as to be a little larger such that unburnt gas was intruded into the engagement space between the insulator 2 and the metallic shell 1 and the number of

cycles for attaining 10MΩ were decreased. From the results described as above, it is considered that the clearance β of less than 0.45 mm makes it possible to improve the fouling resistance of the spark plug 100. Accordingly, it is judged that the clearance β is preferably less than 0.45 mm.

Please replace paragraph [0058], the paragraph bridging pages 33 and 34, with the following amended one:

[0058] Test examples of the spark plugs 100 in which the lengths A by which the clearance β was attained in the space Q were set to 1 to 7 mm, respectively, were prepared. The engine was operated with the above-described test pattern for the heat resistance test and a pre-ignition occurrence advance angle was measured. In the meantime, the length of the metallic shell smaller diameter portion 56 was 1.5 mm, the length from the J portion to the front end of the metallic shell 1 was 12.9 mm and the minimum clearance ~~β~~<u>β′</u> was 0.4 mm. The result is shown by the solid line in FIG. 5. In FIG. 5, the abscissa indicates the length A and the ordinate indicates the pre-ignition occurrence angle (°). In the meantime, the "pre-ignition occurrence angle" is herein intended to indicate the ignition advance angle at which pre-ignition (ignition at too fast timing) occurs.

Please replace paragraph [0063], the paragraph bridging pages 35 and 36, with the following amended one:

[0063] As shown in FIG. 6, when A=1, the number of cycles for attaining 10MΩ was 6. When A=1.2, the number of cycles for attaining 10MΩ was 7. When A=1.5, the number of cycles for

attaining 10MΩ was 8. When A =2, the number of cycles for attaining 10MΩ was 8. When A=3, the number of cycles for attaining 10MΩ was 8. When A=4, the number of cycles for attaining 10MΩ was 7. When A=5, the number of cycles for attaining 10MΩ was 6.5. When A=6, the number of cycles for attaining 10MΩ was 4. When A=7, the number of cycles for attaining 10MΩ was 3. The solid line in the graph has a nearly parabola. By judging, on the basis of the result of the example 2 (refer to FIG. 5), the result of ~~FIG. 4~~FIG. 6 when the length A=1.2 mm or more, it was found that the number cycles for attaining 10MΩ was stably six or more when the length A=5 mm or less (i.e., the finishing point K of the length A for attaining the clearance β of the space Q is 7.9 mm or more from the front end face 60 of the metallic shell 1) but the number of cycles for attaining 10MΩ was rapidly decreased to four when the length A=6 mm or more. Accordingly, it was determined that the fouling resistance was improved when the finishing point K for attaining the clearance β of the space Q was 7.9 mm or more from the front end surface 60 of the metallic shell 1. Further, when the length A is in the range from 1.5 to 3 mm (i.e., the finishing point K of the length A for attaining the clearance β of the space Q is 9.9 mm or more from the front end face 60 of the metallic shell 1), the number of cycles for attaining 10MΩ was eight, i.e., assumed a high value, so that it was determined that the fouling resistance was further improved.

Please replace paragraph [0067], the paragraph bridging pages 38 and 39, with the following amended one:

[0067] As shown in FIG. 8, the pre-ignition occurrence angle was 35.5° when the length Z of the insulator ~~base~~intermediate diameter portion 28 in parallel with the direction of the axis O was 0.5

mm, the pre-ignition occurrence angle was 36.5° when Z=1 mm, the pre-ignition occurrence angle was 37° when Z=2 mm, the pre-ignition occurrence angle was 37.5° when Z=3 mm, the pre-ignition occurrence angle was 38° when Z=4 mm, the pre-ignition occurrence angle was 38.5° when Z=5 mm, the pre-ignition occurrence angle was 39° when Z=6 mm, and the pre-ignition occurrence angle was 39.5° when Z=7 mm. As shown in FIG. 8, the solid line of FIG. 8 ascends rightward when Z=1 mm or more, and the pre-ignition occurrence angle is decreased rapidly when Z=0.5. Accordingly, it was determined that the heat resistance of the spark plug 100 could be improved when Z=1 mm or more.

Please replace paragraph [0074], the paragraph bridging pages 43 and 44, with the following amended one:

[0074] (Example 9)

Then, the result of the heat resistance test of the spark plug 100 in which copper and soft steel are used as the material of the plate packing 8 will be described with reference to FIGS. 2 and 12. FIG. 12 is a graph showing the result of the heat resistance test of the spark plug 100 in which copper is used for the plate packing 8 and the spark plug 100 in which soft steel is used. Test examples of the spark plug 100, in which a conventional soft steel packing was used and the test examples of the spark plug 100, in which a copper packing was used, were prepared. The result of the test is shown by a bar graph in FIG. 12. In the meantime, the length of the metallic shell intermediate diameter portion 56 was 1.5 mm, the length from the J portion to the front end of the metallic shell 1 was 12.9 mm, and the minimum clearance β' was 0.4 mm. The length A of the space Q in parallel with the direction of the axis O is fixed at 3 mm. In the meantime, in

~~FIG. 11~~FIG. 12, the abscissa indicates the pre-ignition occurrence advance angle. The test condition of the heat resistance test was the same as described above.

Please replace paragraph [0076], the first full paragraph on page 45, with the following amended one:

[0076] (Example 10)

Then, the result of the heat resistance test of the spark plug, depending upon a variation of the thread diameter and a difference between the copper packing and the conventional soft steel packing will be described with reference to FIG. 13. FIG. 13 is a graph showing the result of the heat resistance test of the spark plug 100, depending upon a variation of the designation of screw thread (thread diameter) and a difference between the copper packing and the conventional soft steel packing. Test examples of the spark plugs 100, in which the designation of screw thread of the thread portion 7 was M14, M12 and M10, were prepared. The result of the heat resistance test is shown in FIG. 13. In the meantime, the length of the metallic shell intermediate diameter portion 56 was 1.5 mm, the length from the J portion to the front end of the metallic shell 1 was 12.9 mm, and the minimum clearance β' was 0.4 mm. In the meantime, in FIG. 13, the abscissa indicates ~~the pre-ignition occurrence advance angle (°)~~the designation of screw thread and the ordinate indicates the pre-ignition occurrence advance angle. In FIG. 13, ● indicates the spark plug 100 in which the soft steel packing was used, and ○ indicates the spark plug 100 in which the copper packing was used. In the meantime, the test condition of the heat resistance test was the same as described above.

Please replace paragraph [0093], the paragraph bridging pages 53 and 54, with the following amended one:

[0093] Then, a spark plug 300 according to the third embodiment of the present invention will be described with reference to FIG. 16. FIG. 16 is a fragmentary longitudinal sectional view showing a front end side principal potion of the spark plug according to the third embodiment of the present invention in an enlarged scale. In the meantime, the spark plug 300 used for ignition in an internal combustion engine such as an automotive gasoline engine, similarly to the first and second embodiments. The spark plug 300 is configured so that with respect to the electrode front end portion 36 of the center electrode 3, which protrudes from the front end portion of the insulator 2 in the direction of the axis O, a reduced diameter front end part of the electrode front end portion 36 is disposed inside the through hole 6. In the meantime, the spark plug 300 of the third embodiment has almost the same structure as the first embodiment and differs only in that a part of the electrode front end portion 36 of the center electrode 3, which protrudes from a ~~rear side~~front end side opening portion of the insulator 2 in the direction of the axis O, is regulated. Accordingly, description is made as to only the electrode front end portion 36 of the center electrode 3 in the spark plug 300 of the third embodiment, which protrudes from the front end portion of the insulator 2 in the direction of the axis O and description as to the structure of the other portion is omitted by using description of the first embodiment in place thereof.

Please replace paragraph [0095], the first full paragraph on page 55, with the following amended one:

[0095] ~~Further, insertion is made from the front end side of the through hole 6 of the insulator 2 in the direction of the axis O.~~ Further, as shown in FIG. 16, the electrode front end portion 36 of the center electrode 3 protrudes from the front end side opening portion of the insulator smaller diameter portion 30 of the insulator 2. The intersecting point M is positioned at a side closer to the rear end than the front end part of the insulator smaller diameter potion 30 of the insulator 2. Accordingly, the electrode front end portion 36 protruding from the open end portion of the insulator smaller diameter portion 30 of the insulator 2 includes the center electrode smaller diameter portion 72 and part of the center electrode stepped portion 73.